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(54) (TITLE OF THE INVENTION) A Packaging Bag for Protecting the Freshness of Green Goods

(57) (ABSTRACT) A packaging bag for protecting the freshness of green goods wherein, in relation to the net weight % of the green goods to be packaged, the bag has a total opening area of 0.4 ~ 4.0 mm²/kg, and the opening is constructed on the range of 3 < spacing diameter/thickness < 20.

(EFFECT) To provide a packaging bag which is optimal in maintaining the freshness of green goods.

(SCOPE OF PATENT CLAIMS)

(CLAIM 1) A packaging bag for protecting the freshness of green goods characterized in that when storing green goods, in relation to the net weight of the green goods to be packaged in a sealed bag, the bag has a total opening area of $0.4 \sim 4.0 \text{ mm}^2/\text{kg}$, and the opening is constructed on the range of $3 < \text{opening diameter/thickness} < 20$.

(CLAIM 2) A packaging bag for protecting the freshness of green goods as claimed in Claim 1, wherein the opening diameter is $0.1 \sim 0.5 \text{ mm}$.

(CLAIM 3) A packaging bag for protecting the freshness of green goods as claimed in Claim 1 and Claim 2, wherein there is $0.2 \sim 2.0 \text{ weight\%}$ non-ionic surfactants contained within the resin.

(CLAIM 4) A packaging method for protecting the freshness of green goods wherein: when using the packaging bag as noted within Claims 1, 2, or 3 to package green goods into a bag, the ratio of the interior air volume (head space ratio) is greater than 1 and less than 3 in relation to the volume of the green goods.

(CLAIM 5) A packaging method for protecting the freshness of green goods as claimed in Claim 4, wherein the green goods to be packaged is broccoli.

(DETAILED EXPLANATION OF THE INVENTION)

(0001)

(TECHNICAL FIELD OF APPLICATION) The present invention relates to a packaging bag for protecting the freshness of green goods which is effective during the warm period from spring to summer, during which time it is difficult to maintain freshness due to ventilation after packaging and the severity of humidity.

(0002)

(PRIOR ART) In recent years, there have been many movements toward planned overlapped and multiplied agricul-

ture by going away from open-field farming to greenhouse farming in the production of green vegetables, and as a large amount of vegetables are harvested at the same time, it is common for these products to be packaged. Also, as the harvest period is determined, even for vegetables grown in open fields, a large amount of produce must be packaged and shipped within a short period of time, and the biggest problem in the logistics process of getting the packaged goods to the hands of the general consumer is in how best to maintain the freshness of the harvest.

(0003) The most effective method for maintaining freshness of the green goods is to control the gas of the storage environment (mainly oxygen, nitrogen, and carbon dioxide) to a certain level, in other words, to maintain CA (Controlled Atmosphere) conditions. This method has been studied by many people for a long time, and for each type of produce, the optimum CA conditions have been determined (see Table 1). Large-scale storage apparatus for storage under CA conditions are being sold, but as the costs can run high, this type of apparatus is not common among general farming households. Therefore, research to improve the vessels and packaging which can be stored simply under CA conditions has been very active. For instance, in Japanese Unexamined Patent Application Publications S62-235088 and H1-309621, vessels have been disclosed to control the flow of oxygen and carbon dioxide by using a micro-mesh gas permeable panel on one part of the non-permeable vessel. Also, in Japanese Unexamined Patent Application Publications S56-13361, S61-216640 and S63-102634, packaging has been disclosed to approximate the CA conditions for the gas constituents within the packaging by using a large gas permeable film.

(0004) (TABLE 1)

(TABLE 1) Optimum CA Conditions for Each Kind of Produce

Produce	CA Conditions (%)	
	Oxygen	Carbon Dioxide
Broccoli	1 ~ 2	5 ~ 10
Strawberries	5 ~ 10	10
Fresh Shiitake	6 ~ 10	10 ~ 15
Spinach	10	10

Cited Literature

Kankendō, "Logistics, Storage, and Processing of Greenhouse Produce," 152 pp., Takayuki KURETANI, Hirosato KITAKAWA, 1986

(0005)

(PROBLEM TO BE SOLVED BY THE INVENTION) However, even if there are no problems in using these types of materials under low temperature conditions, in the case of produce such as broccoli, wherein the respiration rate increases dramatically along with an increase in temperature, even when using polybutadiene, which is generally used as a plastic material with a large ratio of gas permeability, the gas permeability may still be insufficient, resulting in concentrations of oxygen within the bag which are too low so the produce suffocates, and resulting in concentrations of carbon dioxide which are too high, leading to problems in abnormal biological reactions.

(0006) Therefore, one method to increase the gas permeability of the film overall is to physically open pores on one part of the film. By adjusting the size and number of the pores, in other words, by adjusting the area of the pore parts, it is possible to obtain a high gas permeability which is not achieved through a film alone.

(0007) For instance, as shown in Japanese Unexamined Patent Application Publications S54-40793 and S63-119647, there have been bags proposed with pores opened in one part, but as the pore area is too large (in other words, the gas permeability is too high), and because the hole diameter is too large, the packaging is affected by the surrounding airflow, and it is not possible to satisfy such requirements as the adjustment of the gas constituents. Also, for instance, in Japanese Unexamined Patent Application Publication H2-85181, as the hole diameter is too small, and the holes can become plugged due to water inside the packaging, it is not possible to obtain the required gas permeability, leading to the danger that it might not be possible to sufficiently obtain a gas adjustment function.

(0008) The aim of the present invention is to provide a packaging bag for maintaining freshness which can realize oxygen and carbon dioxide permeability, and which can be used under the optimum CA conditions for biological operation of the green produce.

(0009)

(MEANS FOR SOLVING THE PROBLEM) The inventors of the present invention have worked on research regarding packaging bags for maintaining freshness of green produce which have heretofore been seen as difficult to store. As a result, by creating pores of a certain size on either one part or over the entire surface of the packaging bag for maintaining freshness, we have discovered that it is possible to control the gas constituents within the packaging containing the produce similar to the CA conditions, leading to the completion of the present invention.

(0010) In other words, the present invention relates to a packaging bag for protecting the freshness of green goods characterized in that, when storing green goods, in relation to the net weight of the green goods to be packaged in a sealed bag, the bag has a total opening area of $0.4 \sim 4.0 \text{ mm}^2/\text{kg}$, and the opening is constructed on the range of $3 < \text{spacing diameter/thickness} < 20$; and to a method for maintaining freshness of produce packaged using this bag such that the ratio of the internal air volume is 1 or greater and 3 or less in relation to the volume of the produce inside.

(0011) Below, we will explain in detail the present invention. According to the present invention, in order to obtain oxygen and carbon dioxide permeability which can lead to the CA conditions, we must construct pores within the range of a total opening area of $0.4 \sim 4.0 \text{ mm}^2/\text{kg}$ in relation to the net weight of the green goods to be packaged in a sealed bag, and the opening is constructed on the range of $3 < \text{spacing diameter/thickness} < 20$.

(0012) In other words, when the total mesh area is less than $0.4 \text{ mm}^2/\text{kg}$ in relation to the weight of the produce to be packaged, the oxygen will be depleted due to the active respiration of the produce, leading to insufficient concentrations of oxygen within the packaging, and to a degradation of freshness, as the minimum level of respiration required to maintain activity will be prevented. Also, at the same time, as the concentration of the carbon dioxide will grow excessive, there will be biological damage, facilitating the generation of bad smells. On the other hand, when the total mesh area is greater than $4.0 \text{ mm}^2/\text{kg}$ in relation to the weight of the produce to be packaged, it will not be possible to reduce the concentration of oxygen within the packaging to levels which can control respiration, accelerating the aging process. Also, at the same time, the level of carbon dioxide will become too low, making it difficult to effectively realize prevention of rotting and to control respiration.

(0113) Also, when packaging green produce in bags, through the respiration and perspiration of the produce, a large amount of water will be generated within the bag, but at this time, the smaller the mesh diameter and the thicker the film is, the more difficult it will be for water to pass through the mesh, making it easy for water droplets to clog the pores. Therefore, in order to avoid having the pores clogged with water droplets, the conditions of $3 < \text{pore diameter/thickness} < 20$ must be met. In other words, when the "pore diameter/thickness" is smaller than 3, as a water film will clog the pores, the gas permeability will be lower than calculated, and if the "pore diameter/thickness" is greater than 20, in addition to gas exchange due to dispersion, there will be the affect of flow (wind) of air externally, making the gas permeability greater than calculated, making it impossible to accurately adjust the gas. At this time, it is preferable that the pore diameter be $0.1 \sim 0.5 \text{ mm}$.

(0014) Further, it is preferable to add $0.2 \sim 2.0$ weight % of a non-ionic surfactant to the resin which forms said packaging. When green produce is packaged, a large amount of water will adhere to the packaging inner surface through perspiration action of the produce. This not only obscures visibility of the product from the outside, but can also result in the growth of microbes on the parts which have come into contact with the product, resulting in rot. Therefore, it is necessary to add anti-clouding properties by adding a non-ionic surfactant to the resin. Examples of the non-ionic surfactant which can be used here are sorbitan fatty ester-type surfactants such as sorbitan monostearate, sorbitan monopalmitate, and sorbitan monolaurate; glycerin fatty ester-type surfactants such as glycerin monostearate, glycerin monolaurate, glycerin monopalmitate, glycerin monolaurate [sic], diglycerin dilaurate, and triglycerin monostearate; polyethylene glycol surfactants such as polyethyleneglycol monostearate; alkylene oxide additives such as alkylphenol and esters of sorbitan/glycerin condensates and organic acids.

(0015) Further, by packaging the produce such that the head space rate is 1 or greater and 3 or less (the ratio of the air volume within the packaging in relation to the volume of the produce), it is possible to quickly create the CA conditions. After packaging, under normal conditions, the gas concentration within the packaging will near the CA condi-

tions without relation to the head space ratio, but when the head space ratio is smaller than 1, the CA conditions for the produce can change and become unstable, and if the head space ratio is greater than 3, it can take some time to reach the CA conditions. It is important to quickly create the CA conditions by minimizing the head space as much as possible in order to prevent degradation in initial freshness of the produce.

(0016) As said packaging has an extremely high level of gas permeability, respiration is active, and it particularly effective in those products which are thought to be difficult to maintain at a level of freshness. An example of this type of produce is broccoli.

(0017) The method to process the mesh of $0.1 \sim 0.5 \text{ mm}$ is, for instance, by heating an extremely narrow needle, and using it to puncture a film, or it is also possible to use a carbonic acid gas laser, but with either [method], it is easy to perform continuous processing, and the cost is low.

(0018) The method to process the film into a bag is not specified in particular, but for instance, it is possible to take the film which has been processed into a cylinder shape using the conventional inflation mold and to obtain bags by cutting it using a heat seal. For individual packaging, it is possible to match the shape of the produce, or when packaging boxes, it is possible to use a heat-seal-processed product in a shape which follows the inner sides of a cardboard box.

(0019) It is necessary that the film material have an appropriate gas permeability, which is cheap and which has excellent transparency. Examples of resins which meet these conditions are: low-density polyethylene, high-density polyethylene, polypropylene, ethylene acetic acid vinyl copolymers, polystyrene, and cellulose-type resins. It is preferable that the thickness of the film be $20 \sim 80 \mu\text{m}$, taking into considering the total gas permeability and the appropriate strength and economics.

(0020) Also, it is possible to include within the film which forms said bag anti-clouding agents, lubricants, anti-blocking agents, anti-oxidants, ultra-violet absorbers, colorants, and anti-static electricity agents, as necessary.

(0021) The temperature of storage is, of course, low, but in the cases of the bag of the present invention, even if the temperature increases, by adjusting the pore area to match the respiration rate at various temperatures, it is possible to achieve the CA conditions. Therefore, it is effective in use in a range of comparatively high temperatures from 10°C to 20°C .

(0022)

(EFFECT OF THE INVENTION) By packaging green produce in the packaging bag according to the present invention, it is possible to maintain freshness over a long period of time by leading the gas constituent within said bag close to the conditions which are effective in maintaining freshness. Currently, it is common to use large-scale storage compartments to maintain freshness of produce through gas adjustment, but not only does this involve cost in implementing the apparatus, the storage conditions can vary for each type of produce, making it difficult to store a wide variety of produce at the same time. Simply by packaging produce in the packaging bag in the present invention, it is possible to obtain the efficacy of CA conditions, making it convenient and economic.

(0023) In particular, in the case of broccoli, it is possible to maintain freshness even during the hot season from spring to summer, which has thought to be difficult in terms of storage and transport, without requiring facilities for low temperature transport or refrigerated materials, and further, without requiring Styrofoam in packaging, which is a problematic material for disposal. Also, further, if each piece of produce is hermetically sealed individually at the farm, then there is no need for them to come into contact with external air once sealed, and it is possible to sell the product at the store while maintaining freshness.

(0024)

(EXAMPLE OF EMBODIMENT) Below, we will show examples of embodiment of the present invention, but the present invention is not limited to this example of embodiment.

(0025) We measured the gas constituents within the bag by sampling the gas (10 cc) within the bag using a syringe needle in the rubber seal part (area 1 cm²) which was attached to one part of the bag, using an oxygen concentration meter and a carbon dioxide concentration meter (Toray Engineering). Also, for the evaluation of the freshness, we visually observed the external appearance and any discoloration, and for the odor, we evaluated the odor generated from the interior of the bag using the below criteria.

Color	O: No discoloration noted Δ: Some discoloration noted X: Complete discoloration
Odor	O: No odor detected Δ: Some odor noted X: Very unpleasant odor
Rot	O: No rot detected Δ: Some rot noted X: Entire product has softened, much rot

(0026) Example of Embodiment 1

Adding 1.5 weight% of a surfactant (Sakamoto Chemicals, diglycerin stearate) to a resin, we heated a needle and inserted it into a low-density polyethylene bag of total surface area 0.1 m² (size 25 × 20 cm, thickness 60 μm, oxygen permeability 4190 cc/m²-day, carbon dioxide permeability 18860 cc/m²-day) which was formed from a film which had been inflation-molded, and placing one head of broccoli (250 g) into the packaging bag (total mesh area per net weight 1.70 mm²/kg), which had 6 mesh holes of diameter 0.3 mm (hole diameter/thickness = 5), such that the head space ratio would be 2, and heat sealing the bag, it was stored at 20 °C and 65%RH. For a period of 10 days, we measured the gas constituents within the bag, and the results of the observations of the freshness of the broccoli are shown in Table 2.

(0027) Example of Embodiment 2

Adding 1.5 weight% of a surfactant (Sakamoto Chemicals, diglycerin monostearate) to a resin, we heated a needle and inserted it into a low-density polyethylene bag of total surface area 0.4 m² (size 40 × 50 cm, thickness 60 μm, oxygen permeability 4190 cc/m²-day, carbon dioxide permeability 18860 cc/m²-day) which was formed from a film which had been inflation-molded, and placing twelve heads of broccoli (3 kg) into the packaging bag (total mesh area per net weight 0.50 mm²/kg), which had 23 mesh holes of diameter 0.3 mm (hole diameter/thickness = 5), such that the head space ratio would be 2, and heat sealing the bag, it was stored at 20 °C and 65%RH. For a period of 10 days, we measured the gas constituents within the bag, and the results of the observations of the freshness of the broccoli are shown in Table 2.

(0028) Based on the results in Table 2, in examples of embodiment 1 and 2, after two to three days from beginning the storage, the gas constituents within the bag had stabilized at a level near the optimum CA conditions for broccoli (oxygen 2%, carbon dioxide 10%), and there was no change for the following 10 days. Also, the freshness was well preserved, and with the produce staying green, there was no rotting or odor detected.

(0029) Comparative Example 1

In the first example of embodiment, other than changing the example to have no mesh (total mesh area per net weight 0 mm²/kg), the sample was the same. The evaluation results are shown in Table 2.

(0030) Comparative Example 2

In the first example of embodiment, other than changing the example to have three holes (total mesh area per net weight 0.07 mm²/kg), the sample was the same. The evaluation results are shown in Table 2.

(0031) Comparative Example 3

In the first example of embodiment, other than changing the example to have 18 holes (total mesh area per net weight 4.5 mm²/kg), the sample was the same. The evaluation results are shown in Table 2.

(0032) Comparative Example 4

In the first example of embodiment, other than changing the example to not seal the product in the bag, the sample was the same. The evaluation results are shown in Table 2.

(0033) Above, in Comparative Example 1, where there were no holes, and in Comparative Example 2, where the mesh ratio was low, the level of oxygen within the bag was insufficient, and the level of carbon dioxide was excessive, so while the green color was maintained, the odor was strong and the product value was lost. In contrast, in Comparative Example 3, where the mesh ratio was too large, and in Comparative Example 4, where the product was not sealed, as the level of oxygen was high, so it was not possible to control respiration and the product turned yellow. Further, in the case where the product was not sealed, rot was significant due to the generated water content.

(0034) (TABLE 2)

(TABLE 2) Freshness Maintenance Efficacy for Broccoli

	Packaging Conditions		Gas concentration (%) within the bag								Freshness Evaluation Efficacy											
	Mesh area by weight (mm ² /kg)	# of Holes	10 hours		1 day		5 days		10 days		10 hours			1 day			5 days			10 days		
			O ₂	CO ₂	O ₂	CO ₂	O ₂	CO ₂	O ₂	CO ₂	Color	Odor	Rot	Color	Odor	Rot	Color	Odor	Rot	Color	Odor	Rot
Example 1	1.70	6	4.0	11.0	1.3	14.6	1.6	13.0	1.3	13.3	0	0	0	0	0	0	0	0	0	0	0	0
Example 2	0.50	23	2.0	12.5	1.2	14.2	1.0	13.5	1.1	12.0	0	0	0	0	0	0	0	0	0	0	0	0
Comp. Ex. 1	0	0	0.1	15.4	0.3	21.1	0.1	17.7	1.8	7.9	0	Δ	0	0	X	0	0	X	0	0	X	0
Comp. Ex. 2	0.07	3	2.6	12.3	0.4	16.1	1.0	11.7	2.8	14.4	0	0	0	0	Δ	0	0	X	0	0	X	0
Comp. Ex. 3	4.50	18	10.7	8.0	9.3	8.7	6.4	11.8	7.5	11.1	0	0	0	0	0	0	X	Δ	0	X	Δ	Δ
Comp. Ex. 4	—	—	20.3	0.0	20.3	0.0	20.3	0.0	20.3	0.0	0	0	0	Δ	0	0	X	0	0	X	0	0

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